Technical Report

Gender Gaps in Food Crop Production and Adaptation to Climate-Smart Technologies:

The Case of Western Highlands of Cameroon

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Executive Summary

Food crop production in Cameroon is mainly rain-fed and highly dependent on the climate which has been changing over several decades. Evidence has shown define climatic change taking place in Sub-Saharan Africa (SSA), manifested in a slow but steady rise in temperatures and a general decline in rainfall. Thus, posing threats to agricultural production, sustainable development and the attainment of the Sustainable Development Goals (SDGs) which is linked to other goals related to water, food, energy and gender. Even though climate change is widely recognized as an international problem, the gender question has received insufficient attention as discussed in COP-15 in Copenhagen. On a positive side, this conference, showcased the most significant participation of women in any COP meeting. The gender quality language increased, with many gender-sensitive texts incorporated into the negotiating documents. Many women delegates chaired working groups and plenary sessions, a notable change from past years. The gender texts incorporated at the COP noted women's acute vulnerability to climate change, and also emphasized the importance of a gender perspective: equitable participation of women and men at all stages of addressing climate change causes and impacts. It is thus critical for policy makers to understand how both women and men farmers experience and adapt to climate change to redesign or formulate new policies that support food production by women and men thereby reducing food insecurity in the country.

This survey analyses the gender gaps which exist in food crop production especially haricot beans in the western highland of Cameroon as farmers struggle with climate change and which climate smart technologies they need use to mitigate or adapt to these changes. Specifically, this research effort seeks to identify women and men farmers' perception of climate in relation to crop production. Determine the effects of climate change and climate related activities on producing food. Identify adaptation and mitigating strategies used by women and men as they grow food and lastly identify factors that enable or constrain women and men farmers' from using climate smart technologies.

Purposive, stratified and simple random sampling techniques were employed to select the communities and farmers in the western highland. Interviews were conducted with 180 female and male farmers using semi structured questionnaire through the face-to-face interview technique. Data were analyzed using Statistical Package for Social Sciences (SPSS version 21). Descriptive

statistics in the form of frequencies and chi-square test were used to present quantitative data, while the qualitative data was analyzed through theme identification and inductive reasoning.
Results revealed that farmers perceive climate change as an increase in temperatures and decrease in rainfall which affects food crop production through reduction in crop yields, increased incidence of pest and diseases, yellowing and drying of leaves and tubers rots. Other effects of climate change on related farming activities include difficulty in preparing land for cultivation, shifting in planting dates and increased in pesticides application. These farmers respond to the effects of climate change by employing adaptation measures such as shifting planting dates, irrigation and application of pesticides to sustain food production. The work argues that improving farmers' knowledge on climate change, provision of improved seeds varieties and increased access to credit facilities will prepare farmers especially women for the challenges of climate change.

Table of Contents

List of Tables

Table of Figures

1.1 Background

The fact that agriculture is central to the economy of most countries in the world demands greater attention in addressing concerns of climate change to safeguard and promote economic growth (Mendelsohn, Dinar, and Dalfelt, 2000). This is particularly true for developing world, whose agricultural sector is most vulnerable to climate change because of its dependence on rainfall. Agronomic studies carried out by the International-governmental Panel on Climate Change (IPCC), suggest that crop yields could fall quite dramatically in the absence of adaptation measures (IPCC, 2007a). Despite the economic importance of the agricultural sector in SSA, its performance is relatively poor compared to other developing countries. According to Calzadilla, Zhu, Rehdanz, Tol and Ringler (2009), SSA agriculture has been stagnating due to its - dependence on rain-fed agriculture and the prevalence of pests and diseases. Also, low use of fertilizers, -limited use of improved high yielding crop varieties, degraded soils and inadequate investment in research and development are additional factors that hamper agricultural transformation in SSA (FAO, 2010a and 2008a).

Even though the above mentioned factors undoubtedly account for the poor performance of African agriculture, there is another crucial factor – climate change. According to IPCC (2007a), climate variability observed in the SSA continent has manifested in a slow but steady rise in temperatures and a general decline in rainfall beginning from the first half of the 19th century. These climatic changes are also being observed in Cameroon with effects on its agricultural sector. The agricultural sector constitutes the backbone of the Cameroon economy contributing about 35% to the country's Gross Domestic Product (GDP). About 80% of the people work primarily in one agricultural activity or another with 70% of the national labor force employed in the agricultural sector, living mainly in rural areas (Endeley and Sikod, 2007). The works of Endeley and Sikod, 2007, holds that women produce 90% of total food crops and constitute 88.6% of the active labor force. As indicated in Tchoffo, (2009), primary food crops cultivated by smallholder farmers, are; cassava, maize, cocoyam, taro, sorghum, millet, haricot beans, potatoes, yam, and plantain; while the major cash (export) crops are cocoa, coffee, cotton, rubber, oil palm, and banana.

However, with this great potential, climate change poses a threat to agriculture in Cameroon because the sector is heavily dependent on rainfall with most crops cultivated under rain-fed conditions. Any changes in rainfall and temperature patterns would therefore negatively affect the quantity and quality of food produced. Changes in temperature and rainfall have been shown to affect agriculture through a reduction in crop yields, increased incidence of pest and disease, limited availability of water, reduction in soil fertility, erosion due to strong winds, and wild fires in the dry season (Ching, 2010 and IFPRI, 2009). Adaptation is widely recognized as a vital response to climate change. Thus, without adaptation, climate change is detrimental to the agricultural sector. Adaptation also reduces the vulnerability of farmers to climate change (Easterling *et al*. 1993, cited in Gbetibouo, 2009). According to Maddison, (2006), adaptation to climate change requires that farmers first notice that the climate has changed or is changing, and then identify useful adaptation options and implement them.

Even though climate change is widely recognized as an international problem, the international community has failed to perceive the problem from a social standpoint. The social dimension has been widely neglected, probably because the debate on climate change has been dominated by technological voices (Manata and Papazu, 2009). Ignoring the gender standpoint is indicative of existing global inequalities. According to Baten and Khan (2010), gender discrimination which is one of the striking dimensions and manifestations of inequalities has often been overlooked in climate change-related discussions and interventions. The International community acknowledges gender as an essential component of the development process as spelt out in the Sustainable Development Goals (SDGs) 5 (UNDP 2009). However, discussions on the gender dimensions on climate change is a very recent development which started in the eight conference of Parties (COP-8) in New Delhi in October 2002 (Omari 2010; Agwu and Okhimanhe 2009). Even with this initiative, the gender question still has insufficient attention as discussed in COP-15 in Copenhagen (Manata and Papazu 2009). There is need to differential between women and men as far as climate change process is concerned since both sexes perform a different role in agriculture and the society in general.

Although many studies acknowledge the impact of climate change, there is little data, research or case survey exemplifying the gender differences especially for specific food crops, which this survey will provide (Omari 2010; Lambrou and Piana 2006). The differential impact of climate change on women and men results from social norms, traditional roles, power structures and political positions (Deressa *et al.* 2008). Also, the gender division of labour results in women high representation in agricultural and informal sectors that are vulnerable to environmental change, making women more vulnerable to climate change in Sub-Saharan Africa (Omari 2010). For instance, women in Sub-Saharan Africa have a multi-dimensional role to play as mothers, caretakers, providers, producers and natural resources managers; and, sometimes the head of the family (Denton 2000). Climate change as experienced in the form of warmer temperatures, decreasing rainfall and lower water quality, is predicted to cause severe problems for women by making their productive and reproductive demanding. The shortages of resources such as water and fuel wood (caused by climate change) increase women's workload. Spending more time on such traditional tasks additionally reinforces the workload and reduces women's time to take up productive activities like adopting adaptation strategies in crop production (Denton 2000). Even though both women and men are engaged in different adaption strategies, Quisumbing & Pandolfelli, (2010), assert that majority of women employ non-technical adaption measures because they lack access to and control over assets and decision-making power which can enable them make use of technical adaptation strategies such as irrigation.

It is in this light, that this survey seeks to investigate whether women and men farmers employ similar and/or different coping strategies to mitigate the effect of climate change on food crop production in Cameroon. Women and men are confronted with a variety of gender roles, social norms, and power structures, which may influence their access to education, wealth, training and agricultural production resources that may enhance or constrain their adaptive capacity to climate change. The purpose of this survey is to understand how these factors influence women and men farmers' food crop especially haricot beans production and the types of climate smart agricultural technologies they employ to minimize its effects on food crop production activities in the western highland of Cameroon.

The primary and specific research objectives of this survey are as follows:

1.2 The main objective

Examine the gender gaps which enable or constrain farmers from using climate smart technologies to mitigate the effects of climate change on food crops production in the western highland of Cameroon.

1.2.1 Specific Objectives

1. Identify the existing gender gaps in food crop activities;
2. Identify women and men farmers' perception of climate variations;

3. Determine the effect of climate change on food crops and other farming related activities (land preparation, time of planting, fertilizers and pesticide application, weeding and crop yields);
4. Identify adaptation strategies used by women and men food crop producers to mitigate the effect of climate change;
5. Identify the factors affecting women and men farmers' adaptation to climate smart technologies.

2.0 Methodology

2.1 Characteristics of the survey area

Cameroon is located in the Gulf of Guinea. It has an area of 475, 500sq Km, spread over a distance of 1,840 km from south and north and lies between latitudes 20^0 and 130^0 and longitude 80^0 and 160^0 E (Harvard, and Vall 2003). The population of Cameroon was about 20 million in 2006 and has a growth rate of 2.8% (Molua, and Lambi 2006). The country shares boundaries with Nigeria to the West, Chad to the North East, the Central African Republic to the East, and Equatorial Guinea, Gabon, and the Republic of Congo to the South. The country has all climatic and vegetation types of the continent – coasts, desert, mountains, rainforest and savannah (Molua, and Lambi 2006). The Cameroon Institute of Agricultural Research for Development (IRAD) has classified Cameroon into five distinct agro-ecological zones (see figure 1) differentiated by rainfall, climate, vegetation and soil characteristics. They are (i) the sudano-sahelian zone, (ii) the high guinea savannah zone, (iii) the western highland zone, (iv) the humid rain forest with a monomodal rainfall pattern, and (v) the humid rain forest with a bimodal rainfall pattern (IRAD, 2007).

Cameroon has two major seasons, dry and wet, with most of the rain falls between April and October. The southern part of Cameroon has an average temperature of about 25^0C, while the extreme Northern part has very high daily temperatures, usually between 25^0C and 34^0C, with a lot of sunshine (Molua 2009; IRAD 2007; Molua and Lambi 2006a).

Out of the five agro-ecological zones indicated above, the survey was carried out only in the western highland agro-ecological zone. We purposively selected this agro-ecological zone because of its high intensity of food crop production. Therefore, the survey set out to investigate if women and men food crop farmers perceive climate change similarly or differently taking into consideration the different crop type cultivated and if they carry out similar or different strategies to adapt to the changing climatic conditions.

Figure 1: Map of Cameroon showing the five agro-ecological zones

Source: IRAD **Annual report (2007)**

2.2 The western highland agro-ecological zone

The western highland agro-ecological zone is found in two administrative regions of Cameroon – the North West and West region. This zone covers a surface area of 31.192km^2, and is often referred to as the 'grass fields' because it is made up of wooded grasslands. The landscape is made up of mountains, hills and valleys. Cattle rearing is a popular activity in the zone due to the abundance of grass. The soil is basaltic, with a high content of iron (Molua, 2006a). The mean monthly temperature ranges from about 15^{0}C on the highland to about 27^{0}C in the low-lying regions. The climate of this zone is characterized by seasons: the rainy season lasts from about March to October, and the dry season from November to about March (Tchuinte, 2011). The annual rainfall varies from approximately 1,300mm in the plains to over 3,000 mm on highland peaks. Most of the agricultural activity takes place during the rainy season since the region is poorly equipped with irrigation infrastructure (Molua, 2006a).

Agriculture is the primary occupation of about 70% of the people of this zone and most of the food crop farmers are women. The zone is conducive for many types of crops such as haricot beans,cocoyam, yam, cassava, Irish potato, sweet potato, carrot, tomato, green spices, and cabbage, plantain, banana and maize. Other crops include upland rice which is mainly grown in the wetlands like the Ndop plain (Molua and Lambi, 2007).

2.3 Research design

The survey adopts a cross-sectional design which makes it possible to survey the gender gaps in food crop production and adaptation to climate smart technologies in the western highland of Cameroon. A mixed method was used to collect information from women and men farmers. Data was collected on: (i) farmers' profile and they type of crops cultivated (ii) farmers' perception on climate change and how it affects the different crop types cultivated (iii) Lastly, the different strategies used by women and men farmers to adapt to these changes and factors limiting these adaptive measures.

2.4 Population, sample size and sample procedure

The target population for this survey constituted women and men farmers who cultivate varieties of food crops in the western highland. The data was collected from three sub-divisions in each of the two regions. That is Bafou, Foumbot, and Mbouda (West region), Santa, Babessi, and Ntumbaw (North West region). The selected areas reflected the diversity of production/market contexts ranging from commercial to semi-subsistence and subsistence and are also high beans production zones.

One hundred and eighty farmers composed of 90 women and 90 men was selected using a multi-stage, stratified and random sampling techniques. Below is a detailed description of the sampling procedures presented in Table 1.

A multi-stage sampling procedure was used to select the villages and households included in the survey. In stage one, the purposive sampling technique was used to select the western highland agro-ecological zone. This agro-ecological zone was purposively selected because it constitute the major bread-basket of Cameroon which fuels not only the country but most of the neighbouring countries. Given that the overall goal of the project is to understand gender dynamics in access and control over climate smart technologies in haricot beans production, and subsequently increase in farmers' income, food and nutritional security and overall livelihood of the rural and urban communities. It was important to work in communities with high haricot beans production to understand the effects of climate changes as well as to identify which climate smart technologies are used by women and men farmers. For logistical reasons, the survey covers six out of the fifteen divisions in the western highland.

In stage two, a sampling frame of the divisions (administrative units) in the West and North West regions were constructed and three divisions were purposively selected per regions. Again, these were divisions where haricot beans production is high. Among the eight divisions of the West regions - Menoua, Noun, Mifi, Bamboutous, Haut-Nkam, Haut-Plateaux, Koung-khi, and Nde, three were selected for the survey – Koung-Khi, Noun, and Bamboutous. Amongst the seven divisions that make up the North West region – Mezam, Momo, Menchum, Ngoketunjia, Boyo, Bui and Donga-Mantung, three were purposively selected for the survey (Mezam, Ngoketunjia, and Donga-Mantung).

The next stage involved construction of the sampling frame of sub-divisions and villages. Both sub-divisions and villages were randomly selected among the different divisions and sub-divisions in the two regions. This process led to the selection of one sub-division per division and two villages per sub-division.

At the end of the sampling exercise, 30 farmers (15 women and 15 men) were selected from two villages in each sub-division. Ninety farmers were interviewed from each of the regions; making a total of 180 farmers of equal proportion of women and men (Table 1).

Table 1: Distribution of farmers by survey area

AEZ	Region	Division	Sub-division	No. Villages	No. Women	No. Men
Western Highland	West	Koung-Khi	Bafou	2	30	30
		Noun	Foumbot	2	30	30
		Bamboutos	Mbouda	2	30	30
	North West	Mezam	Santa	2	30	30
		Ngoketunjia	Babessi	2	30	30
		Donga-Mantung	Ndu	2	30	30

Source: Author's field data, 2018

2.5 Data collection

Consultation was done with staff at the delegations of the Ministry of Agriculture and Rural Development (MINADER), council officers and staff at the meteorological office to gather data. This secondary data collection was carried out between December 2017 and January 2018, while the collection of primary data (semi-structured interview and focus group discussions) were conducted between February and March 2018. Both qualitative and quantitative methods were used to collect data at three levels: (i) consultation and secondary data collection (ii) field survey (iii) focus group discussions. Table 2 shows the specific research tools and approaches used in the survey at each level and summarizes the corresponding type of information collected.

Table 2: Research tools and approaches used for data collection

Level of implementation	Research tools, approaches and type of information
Secondary data collection	A formal meeting with divisional and sub-divisional delegates of MINADER was guided by a checklist. After which published and unpublished data was consulted to complete information from government actors.
Field survey	Individual farmers' interview via a semi-structured questionnaire on: Farmers' demographic characteristics: Farmers' involvement in food crop production; Farmers' perception of climate change; Effect of climate change on crops and related farming activities and Adaption strategies used by farmers to adapt to climate change.
Focus group discussion	Key informant interviews with farmers that have a broader knowledge of climate change effects via a checklist on: Effects of climate change on specific crop types;

	Adaptation strategies used by farmers for different crop types and Factors limiting these adaptation measures

Source: Author's field data, 2018

2.6 Data analysis

A triangulation process was adopted in analyzing data by combining qualitative and quantitative approaches in the analysis and interpretation of results. Data were analysed using a number of approaches. A descriptive and statistical methods such percentages as Chi-square test were respectively used to analyse data from farmers via a semi-structured questionnaire. Categorical variables such as 'sex' and 'income' were analyzed using descriptive statistics presenting the distribution of responses in the form of frequencies and proportions. Multiple responses analysis was also used to analyse concepts or opinions which emerged from open-ended questions like 'How is the change in temperature affecting the crops you cultivate?'

3.0 Results and Discussion

Introduction

The thrust of this survey examines the gender gaps and adaptation strategies used by women and men farmers to mitigate the effects of climate change on food crops production. The review of literature and methodology of the survey were all geared towards understanding whether differences exist in women and men farmers' perception and adaptation to climate change in the western highland of Cameroon. It is worthy to note that, the resources (capital) endowment to which farmers have, or do not have access to, are presented in the findings as demographic characteristics. Also, vulnerability context of shocks caused by climate change in food crop production is presented as effects of climate change on crops and other related farming activities. The adaptation strategies are presented as measures developed by farmers to reduce vulnerability to climate change to sustain food production. In this regard, therefore, four themes arise which makes up the central arguments of this survey. (i) perception of climate change by both women and men farmers, (ii) effect of climate change on crops and other related farming activities, (iii)adaptation strategies employed by both women and men farmers, and differences in the adaptation measures employed, (iv) existing gender gaps in the adaptation strategies.

The findings on themes are presented in separate sections, the first section describes farmers' demographic characteristics, in terms of age, level of education, marital status and income generating activities. Farmer's involvement in food crop activities is presented in the second section, followed by the crops and different season in which they are grown. The third section describes how farmers perceive climate change, through changes in temperature and rainfall as well as its consequences on food crop cultivated. It is worthy to note that only changes in temperature and rainfall were considered in this survey. Other parameters such as atmospheric pressure, cloud cover, atmospheric humidity and prevailing winds were left out since this cannot easily be expressed by farmers.

Farmers' vulnerability to the shocks caused by climate change is examined in the fourth section, firstly by presenting the effects of climate change on crops and crop yields, followed by the effect of climate change on other related farming activities (land preparation, time of planting, weeding, fertilizer and pesticide application). Finally, the fifth section describes the adaptation strategies employed by farmers to mitigate the effects of climate change as well as the factors which prevent them from adapting to climate change.

3.1. Farmers' demographic characteristics

3.1.1 Age of farmers

The findings on the age of respondents as presented in figure 2. Majority of farmers studied, irrespective of the region were between 51 and 55 years old for women, and 56 and 60 years old for men. Conversely, fewer farmers irrespective of sex, were in the age group of 66 years and above. However, there were many more men (8.3%) above the age of 66 than women (4.7%). It is quite clear that male and female farmers in this survey are old, and we see the needs of youths to revitalize and transform the agricultural sector.

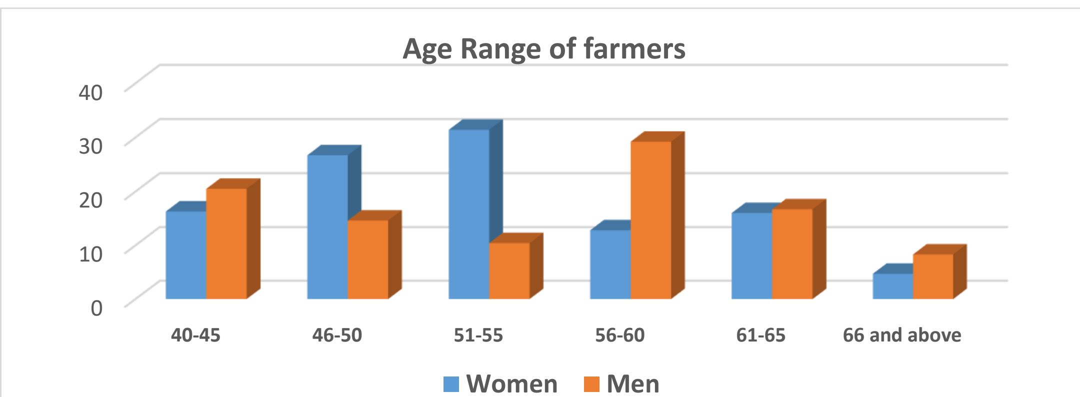

Figure 2: Distribution of farmers by age range

Source: Author's field data, 2018

3.1.2 Level of education of farmers

The data in figure 3 reveal that majority of the farmers have attained primary education, with more women than men. This tie with literature which states that women drop out after secondary education for reasons like marriage compared to men. Worthy to note is the fact that many more men (17.7% and 13.5%) than women (3.5% and 0.0%) attained post-secondary education and university respectively. Therefore, it will be interesting to find out if increased level of education resulted in high adaptation level to climate change or perception of climate change.

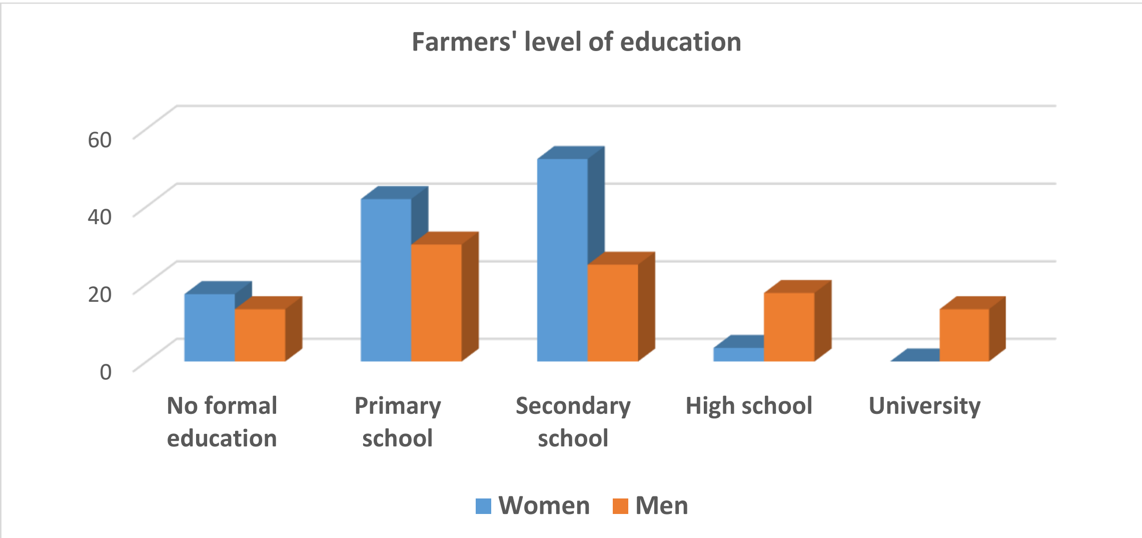

Figure 3: Distribution of farmers by educational level

Source: Author's field data, 2018

3.1.3 Marital status of farmers

The data on the marital status of farmers as presented in Table 3 show that majority of the farmers were married; with more men than women as some women were widows. Among the single category, there were more widows (2.3%) than widowers and those who have never been married among the women.

Table 3: Distribution of farmers by marital status

Marital status	Women (%)	Men (%)
Married	95.3	97.9
Single	2.3	2.1
Widow/widower	2.3	0.0
Total	**100.0**	**100.0**

Source: Author's field data, 2018

3.1.4 Income generating activities of farmers

Female farmers were primarily involved in farming compared to male farmers who were mainly traders. However, women were involved more in hired farm labor and most men were employed out of the farm (Figure 4).

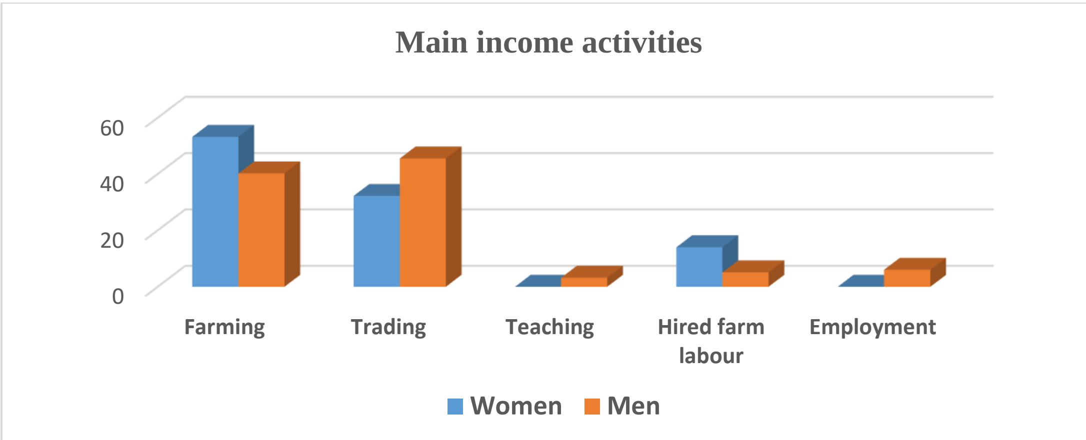

Figure 4: Distribution of farmers by income activities

Source: Author's field data, 2018

3.2 Farmers' involvement in food crop activities

3.2.1 Types of food crops produced by farmers

On the whole, farmers across the western highland cultivated twelve (12) major food crops; namely, haricot beans, maize, cocoyam, yam, Irish potato, sweet potato, groundnut, cabbage, tomato, carrot, plantain and banana (Figure 5). Data ranking of food crops grown in the western highland show that majority of farmers (55.8%) grow maize, haricot beans and other food crops, followed by maize, haricot beans and garden crops (42.9%), maize, haricot beans and potatoes (36.3%), maize and haricot beans (26.7%), haricot beans (20.5%), maize (18.2%), and potatoes (15.4%).

Even though women and men are involved in food crop production, more women than men in the two regions produced the traditional food crops (Table 4). As explained by Ntangsi (1992), the majority of Cameroonian men started participating in food crop production with the coming of the Structural Adjustment Programme (SAP) in the late 1980's when cash crop prices failed in the world market and nationally. These findings are in accordance with Goheen (1996) who argue that although both men and women farmers grow food crops, women are more involved in food crop production owing to traditional gender biases which attribute the burden of household food production and provisioning to women.

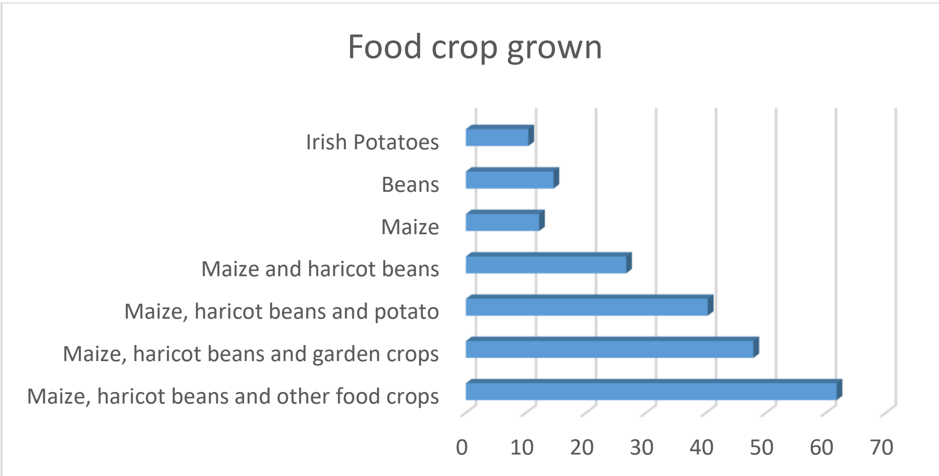

Figure 5: Ranking of food crops produced in the western highland

Source: Author's field data, 2018

Regarding variation by sex, women predominantly produced only maize and haricot beans but also intercropped maize, haricot beans and other food crops or maize, haricot beans and Irish potatoes as well as maize and haricot beans. More men than women cultivated only maize and Irish potatoes but also intercropped haricot beans and garden crops (Table 4). In the North West region farmers did not grow exotic vegetable (cabbage, carrot, green spices and tomatoes) except those in Santa which were mainly grown by men. Hence, confirming literature which says men are more attracted to crops with higher commercial values.

Table 4: Distribution of farmers by food crop produced by sex

Level of education	**Women (%)**	**Men (%)**
Maize, beans and other food crops	78.0	22.0
Maize, beans and garden crops	38.6	62.4
Maize, beans and potatoes	32.2	25.0
Maize and beans	53.5	47.5
Maize	100.0	100.0
Haricot beans	62.0	38.0
Irish potatoes	34.8	66.2

Source: Author's field data, 2018

3.2.2 Number of years involved in food crop activities especially haricot beans and main cultivation season

Overall, information on Table 5 reveal that farmers have been cultivating food crops and the different varieties of haricot beans in the western highland for quiet sometimes and so can perceive the effects of climate change on these crops as well as the mitigation strategies used. Majority (31.9%) of the farmers recounted that they have been cultivating food crops between 21-30 years. This implies that these groups of farmers are well placed to articulate the changes they have noticed in the climate for the past 20 years. Worthy to note is also the fact that majority (43.3%) have been cultivating haricot beans for close to 20 years, of which a good number of this proportion have cultivated improved varieties (bio-fortified, drought and disease tolerant varieties) for about five years.

Table 5: Distribution of farmers by number of years involved in food crops

Number of years					
Food crop cultivation		**Haricot beans cultivation**		**Improved haricot beans cultivation**	
Years	**%**	**Years**	**%**	**Years**	**%**
<= 15	26.9	<= 12	25.3	<= 3	20.3
16-20	26.9	13-20	43.3	4-5	18.1
21-30	31.9	21-25	15.4	6-7	7.7
Above 31years	14.3	Above 26 years	17.0	Above 8 years	13.2

Source: Author's field data, 2018

Looking at the planting season for the different crop types, Figure 6 shows that farmers cultivate particular crops during different seasons. It was observed that majority of farmer's crop during the first cycle (March season). This group of farmers were mostly involved in the cultivation of only maize, and/or intercropped with other food crops. Haricot beans was mostly cultivated in August cycle more than any crop. This season has been established as the best for haricot beans production primarily in the West Region due to climatic compatibility and use of first season maize stalk as staking material.

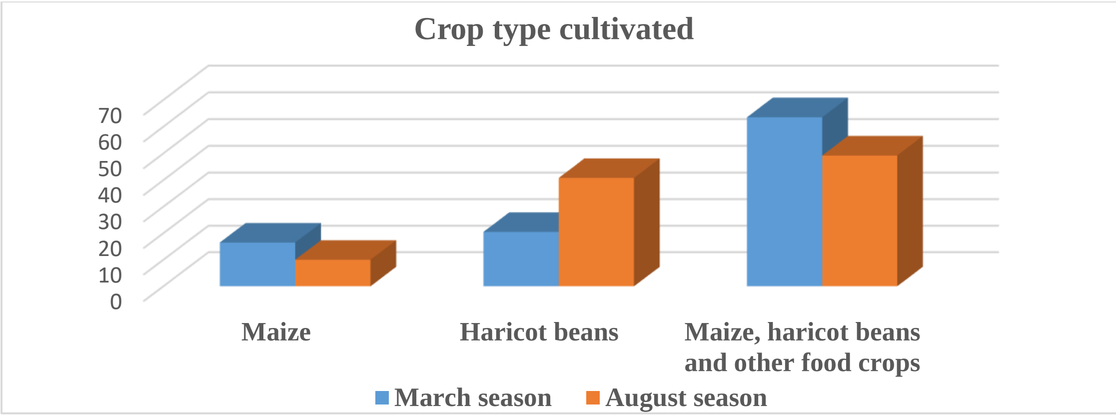

Figure 6: Distribution of farmers by crop type cultivated and planting season

Source: Author's field data, 2018

Figure 7 indicates farmers' involvement in the different planting season by region. Farmers cultivate in all the planting season but in different magnitudes. Overall, farmers (63.2%) in the North West region cultivated more during the first season while farmers in the West region mostly exploited the second season.

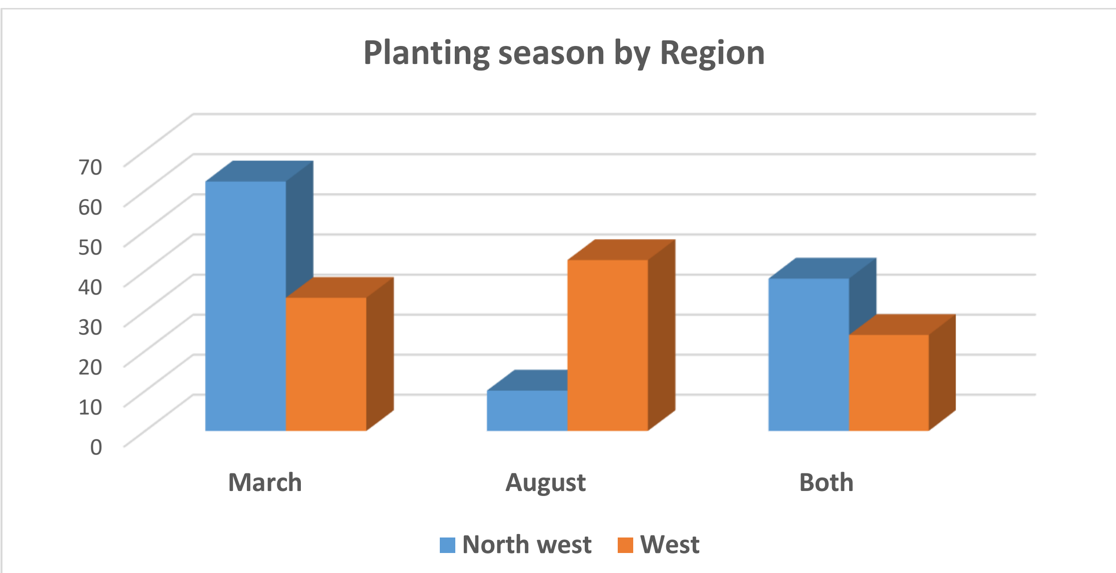

Figure 7: Distribution of farmers by planting season and region

Source: Author's field data, 2018

3.3 Farmers' perception of climate change

According to Lobell *et al.* (2008), the Intergovernmental Panel for Climate Change (IPCC), defines climate change as any change in climate over time, whether due to natural variability or as a result of human activities. Climate change here refers to climate variability observed by farmers or reported from data collected from meteorological centers. These changes are mostly observed from variability in temperature and rainfall.

3.3.1 Farmers' perception of changes in temperature

In Figure 8 majority of the farmers across the western highland observed increased temperatures along with increase sunshine and heat. While others noticed fluctuating temperatures. These findings conform to Maddison's (2006) that a significant number of farmers across eleven Africa countries perceived that average temperatures had increased and rainfall had decreased. Specifically, his findings in Cameroon indicated that 63% of farmers reported an increase in temperatures and at least 65% indicated a decrease in rainfall. Other studies in Cameroon which support this claims include, Ayonghe (2001), which revealed that temperatures trend over Cameroon have been on the increase since 1930 and the net rate of increase has been 0.95 ^{o}C between 1930 and 1995. Precisely, O'Brien (2000) cited in Molua, (2008), reported that the temperatures over Cameroon have been increasing over the past century, with average annual temperature increases ranging from 1.58 ^{o}C to 3.33 ^{o}C, in the coastal zones and 2.13 ^{o}C to 4.53 ^{o}C in the sudano sahelian zone of Northern Cameroon. This increase falls in line with the global trend which is linked to the modification of atmospheric composition with the build-up of Greenhouse Gases (GHG).

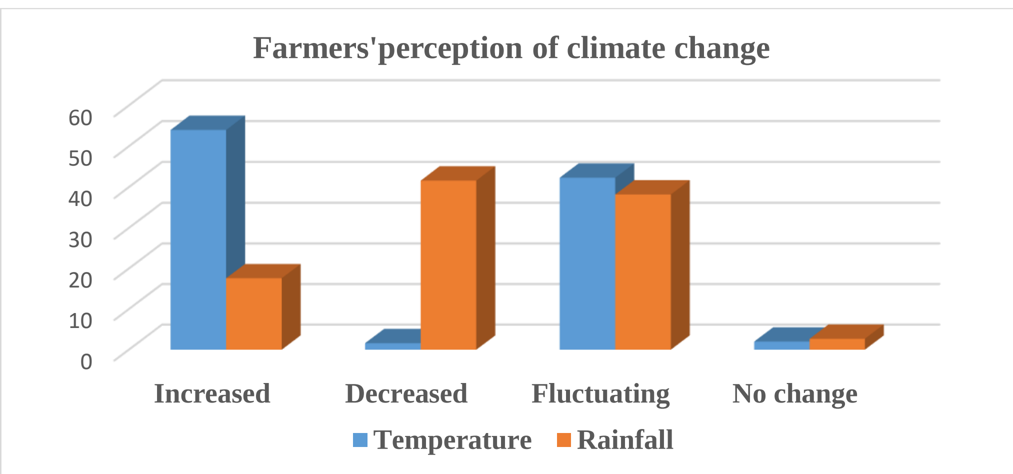

Figure 8: Distribution of farmers by their perception to temperature

Source: Author's field data, 2018

3.3.2 Farmers' perception of change in temperature changes by gender

The findings on farmers' temperature changes showed a gender disparity; a higher percentage of women than men perceived an increase and a decrease in temperature. Increase temperature was noticed by slightly more farmers in the West region than in the North West region (Table 6). More women (71.1%) observed this trend than men (60.8%) across the agro-ecological zone. Women alertness of climate change production process could be explained by their long and vast experience in food crop production, which makes them apt than men to notice any changes in the production activities. This is because the majority of men are new entrants into food crop production business, and so lack the kind of experience that women have would gathered over the years.

Table 6: Distribution of farmers' perception of temperature changes by gender

Rainfall	West Region		North West Region	
	Women (%)	**Men (%)**	**Women (%)**	**Men (%)**
Increasing	72.0	63.7	70.2	58.0
Decreasing	10.0	8.0	20.0	16.0
Fluctuating	17.0	29.0	9.8	26.0

Source: Author's field data, 2018.

In focus group discussions, farmers explained climate variations and the reasons as follows:

"Because of too much sunshine and heat, the main streams we had have dried up and other disappeared; and incidence of malaria is increasing due to many mosquitoes which was not the case before"(63 years old female farmer in Babessi). It should be noted that warmer climates provide more favourable conditions for breeding and proliferation of pest including mosquitoes. Another female farmer aged 51 in Babessi reported that *"I believe that temperatures are increasing because most crops (yam, cocoyam, beans, maize etc.) easily dry off and tuber (cocoyam, potatoes and cassava) gets rotten.* In terms of farming activities, a female farmer aged 46 in Ntumbaw explained that *"Places are too hot making the soil to be too hard and is cracking, leading to low yields".*

Regarding fluctuating temperatures, a male farmer aged 59 in Ntumbaw said *"fluctuations between hot and cold temperature causes uncertainty in the time of planting".* To sum up, both women and men are experiencing changes in temperature which affects both farming activities and crop yields.

3.3.3 Farmers' perception of changes in rainfall

The information in Table 7 shows that changes in rainfall patterns were observed at the onset of rainy season, during the rainy season and towards the beginning of the dry season. All farmers across the western highland recounted that rainy season length fluctuates while 60% says the season has reduced. In the West region 50% of farmers observed a reduction in the rainy season while in the North West region 60% observed fluctuations in the length of the season. Across the highlands farmers agree that the rainy season is fluctuating with farmers in the North West region stating that the rains are coming in earlier than before. Thus making adaptation to climate variability's difficult for farmers who are not sure whether the rains will come on time or not affecting planting dates. Farmers across the highlands indicate that rain pattern fluctuate before the dry seasons, as the rains do not follow predicted patterns but stop before they are expected to.

Table 7: Farmers' perception of changes in rainfall patterns

	West	**North West**
Changes in length of rainy season		
Shorten	50.0	30.0
Increased	9.7	7.5
Fluctuates	40.3	60.8
No change	0.0	1.7
Changes in onset of rainy season		
Starts early than before	24.2	35.0
Starts later than before	25.8	27.7
Fluctuates	48.8	35.0
No change	1.6	3.3
Rainfall changes towards the dry season		
Rain goes early than before	45.2	23.3
Rain prolong than before	3.2	1.7
Fluctuates	48.4	45.8
No change	3.2	0.0

Source: Author's field data, 2018

3.3.4 Farmers' perception of change in rainfall by gender

The data in Table 8 indicate that many more farmers in the North West Region (women 86.0% and men 74.9%) than in the West Region (68.3% women and 59.2% men) observed a decrease in rainfall. This gender difference could be accounted for by a more extended participation of women in food crop production than men.

Table 8: Distribution of farmers' perception of change in rainfall changes by gender

Rainfall	West Region		North West Region	
	Women (%)	**Men (%)**	**Women (%)**	**Men (%)**
Increasing	10.7	8.0	4.0	6.0
Decreasing	68.3	59.2	86.0	74.9
Fluctuating	21.0	33.0	10.4	19.1

Source: Author's field data, 2018

Farmers advanced the following observations in support of their claims to having perceived reduction in rainfall. "*Due to less rains, tuber crops are getting rotten, we use to have a lot of Ibo coco (taro) but we don't have it again because the soil is too dry"* (A female farmer aged 67 in Bafou). A male farmer aged 48 in Santa reported that "*less rainfall causes too much work for the garden crops (carrot, green spices, cabbage, and tomatoes) as one has to water".* This same farmer further recounted that *"shortage of rains increases crop infestation by pests and diseases and causes a delay in the germination of seeds".*

Concerning fluctuation in rainfall, a female farmer aged 67 from Foumbot explained that *"In the early 1960s, the rain usually starts from 15 March, but now it starts at times in February and it stops before November. Sometimes it starts even after 15 March so I really don't know which planting patterns to follow".*

3.3.5 Comparing farmers' perceptions of climate change and data recorded from Meteorological stations

This section compares farmers' perceived changes in the climate (increase in temperature and decrease in rainfall) with data collected from meteorological stations. Unfortunately, meteorological data was available only for Santa in the North West region. Overall, farmer's perceived increase in temperature and decrease in rainfall correspond to available Meteorological data on Santa from 1991-2010 (Table 9) with slight fluctuation in the temperatures figures. These results also correspond to temperature and rainfall data computed from the equation of regression lines from 1940-2060 of Cameroon by Ayonghe (2001).

Table 9: Annual temperature and rainfall data for Santa (2001-2012)

Years	Temperature	Rainfall
2001	19.6	2306.0
2002	19.1	2554.8
2003	19.1	1914.6
2004	19.3	2376.7
2005	20.3	2625.5
2006	19.3	2305.4
2007	21.3	2173.6
2008	21.3	2221.3
2009	19.9	2550.1
2010	20.4	2555.1
2011	N/A	2201.8
2012	N/A	1883.5
Total	**199.59**	**27669**
MEAN	**19.96**	**2305.75**

Source: Regional Delegation of Transport, Bamenda: Service of Meteorology, (2018)

3.4 Effects of climate change vulnerability on crops and related farming activities

This section presents findings on the effects of vulnerability of climate change on food crops and related farming activities. Farmers were requested to describe the effects of climate change on the major crop types cultivated over the past twenty years. Overall, farmers across the western highland cultivated thirteen (13) major food crops; namely, maize, haricot beans, cassava, yam, cocoyam, plantain, Irish potatoes, groundnut, tomatoes, carrot, green spices, sweet potatoes and banana. The findings in this section are presented in two parts as follows: 1) the effects on climate change vulnerability on food crops 2) the effects of climate change vulnerability on related farming activities.

3.4.1 Effects of temperature change on food crops

The findings on the effects of temperatures changes on food crop are shown in Table 10. The effects are presented in the paragraphs below.

(i) Changes in temperature led to a decrease in crop yields was reported for all food crops at averagely 44.5% except for sweet potatoes were only an insignificant proportion (3.3%) noticed a drop in yield.

Farmers attributed decrease in yields from the different crops to; "*Insufficient rainfall and too much sunshine affect maize yields in that the cobs are small in size and the yield is less, hence affecting the overall quantities harvested" (female farmer aged 67 from Santa).* Another female farmer aged 43 from Foumbot said "*Because of little water in the soil, hot weather makes cassava* *roots to be small in size as there is insufficient water to feed them".* A male farmer in Ntumbaw reported that *"High temperature reduces water for the growth of Irish potato, therefore reducing the size of tubers and yield of the crop".* Another male farmer aged 69 in Bafou said *"banana and plantain bunches are small in size and the fingers are scanty as a result of water stress as a result of early drought".*

(ii) The second effect of temperature changes on food crops was increased incidence of pests and diseases. These effect were reported on some traditional crops which are rarely irrigated and whose production is highly dependent on rainfall; including cassava (27.3%), groundnut (24.2%) and haricot beans (23.6%). Pests and diseases were not reported in the cases of banana, plantain, tomato, sweet potato and yam.

These are some of the ways in which farmers viewed the effects of pest and diseases on crops. For maize crop, farmers explained that "*Too much heat makes maggots to increase and the stems are not healthy". In the case of cassava crop, diseases attack the edges of cassava leaves as a result of limited rainfall". Insects eats up cocoyam tubers, resulting to low yields.* This was reported especially by farmers in Babessi who said "*diseases like root rot attack cocoyam especially when places are hot".* Concerning plantain and banana, farmers from Bafou reported that *"black ants' eats up the suckers resulting to low yields".* With regards to Irish potato, farmers in Santa explained that *"Insect attack and eat up the leaves of Irish potato causing them to fold up resulting to poor yields.*

(iii) The third effect of temperature changes on food crop was withering and drying up of plant leaves. This effect was reported on seven crops, maize, haricot beans, cocoyam, yam, plantain, Irish potatoes and groundnut. A higher majority (28.6%) of the farmers reported withering and drying of plant leaves on Irish potato, followed by cassava (25.0%), groundnut (24.2%) and haricot beans (23.6%). Withering and drying up of plant leaves was not reported on irrigated crops such as cabbage and tomatoes due to regular irrigation.

Farmers illustrates withering and drying of leaves in the following ways. For the case of maize crop, *"Too much sunshine and shortage of water makes the leaves to become yellow and dry, which makes the plant to be unhealthy and stunted"* (As recounted by a male farmer in Foumbot). Concerning haricot beans, a female farmer aged 41 in Bafou reported that, *"lack of rainfall causes the leaves of haricot beans to become yellow and shrink, leading to poor yields".*

(iv)The fourth perceived effect of temperature changes on food crops was rotting of tubers, especially of root and tuber crops such as yam, Irish potato, sweet potato and cocoyam. The highest incidence of tuber rot was reported on Irish potato by 30.4% of the farmer, followed by yam (11.8%) and cocoyam (10.6%).

Farmers in Ntumbaw described rotting of tubers in yam in the following ways; '*the roots of yam become black and it does not grow well".*

Farmers in both regions believed that the perceived changes as reported above are as a result of temperature variations.

Table 10: Effects of temperature changes on food crops

Effects of temperature changes on food crops	Crops											
	Maize	**Beans**	**Groundnut**	**Yam**	**Irish Potato**	**Sweet potato**	**Cassava**	**Cocoyam**	**Banana**	**Plantain**	**Cabbage**	**Tomato**
Decrease in yield	41.0	37.4	30.1	67.7	21.0	3.3	33.7	41.6	63.7	70.8	18.7	63.6
Increase in pests and diseases	15.4	23.6	24.2	-	20.0	-	27.3	16.8	-	-	30.6	-
Yellowing and drying of leaves	24.2	8.8	-	-	28.6	-	25.0	8.8	-	-	-	-
Tuber rot	-	-	-	11.8	30.4	-	-	10.6	-	-	-	9.9
Folding of leaves	3.2	-	-	20.9	-	-	1-0.0	-	-	-	-	-
Tiny leaves	-	-	-	-	-	-	-	-	-	-	51.7	-
Produces small bunches	-	-	-	-	-	-	-	-	-	-	-	27.4
Dry soils	-	-	4-6.1	-	-	-	-	-	-	-	-	-
Rotten of grains	-	12.1	-	-	-	-	-	-	-	-	-	-
Erosion of top soil	-	-	-	-	-	-	-	-	-	-	-	-
Drought resistant	-	-	-	-	-	-	-	-	-	-	-	-
Good growth	-	-	-	-	-	-	-	-	2-4.3	6.0	-	-
Disturbance of planting calendar	-	-	-	-	-	-	-	-	-	-	-	-
Slow germination	-	6.0	-	-	-	-	-	-	-	-	-	-
Increase in yield	3.3	4.4	-	-	-	96.7	-	-	12.0	-	-	-
No effect	4.4	7.7	-	-	-	-	4.0	22.1	10.0	23.2	-	-
Produces small cups	9.4	-	-	-	-	-	-	-	-	-	-	-

Source: Author's field data, 2018

3.4.2 Effects of temperature on related farming activities

This part of the survey presents findings on the effects of temperature on other related farming activities (land preparation, time of planting, weeding, fertilizers application, pesticides application and crop yields). Farmers were requested to fill a closed-ended question on the effect of climate change on farming activities in relation to the different crop types they reported to be growing. For example, the effect of temperature changes on land preparation had the following answer categories (i) more difficult (ii) easier (iii) fluctuates and (iv) no change, from which farmers were requested to select one response.

The findings in this section are not disaggregated by regions because farmers across the zones gave similar responses. However, farmers are disaggregated by sex because of a variety of differences in the responses of women and men farmers.

3.4.2.1 Effects of temperature changes on land preparation and planting process

In Cameroon, smallholder farmers usually start their farming activities with land preparation which involved manual clearing, followed by tilling or making of mounds, ridges (commonly called 'ankara') or beds on which seeds, seedlings, cuttings and suckers are planted. The purpose of land preparation is to 1) provide the necessary soil condition for the successful establishment of seeds or transplanted materials, 2) ease sowing, create good seed and soil contact, absorption of moisture by plants, and aeration of soil, 3) control weed, 4) improve the water holding capacity of the soil.

Farmers (77.2%) explained that because of high temperatures and low rainfall, the soil hardens and cracks, hence becoming lumpy, obliging them to spend more time on manual clearing and soil tillage practices than otherwise necessary as shown in Table 16.

Farmers who perceived difficulties in land preparation substantiated their claims in the following ways: a male farmer aged 47 in Santa expressed that "*In the past, my friend and I used to take two days to clear my farm, now it takes us at least four days or more to clear the same farm."* A female farmer aged 62 in Santa also reported that *"Because the soil is too hard and dry, couple with too much heat, it takes my entire household a week to make ridges on the same farm that use to be done for four days"*. Another female farmer aged 52 in Bafou disclose that *"the ground is too dry and strong and grasses are tough, making clearing and tilling too difficult.*

In terms of the effect of temperature changes on planting process, the data presented in Table 11 indicates that almost half of the farmers (58.1%) indicated that planting becomes more difficult as a result of increased temperatures. Farmers expressed that this was mostly noticed during the first season where the soil has not retained enough moisture.

Table 11: Effect of temperature changes on land preparation and planting process

	Effects of temperature changes	
	Land preparation	**Planting process**
Too difficult	76.2	58.1
More time	13.4	31.2
Easier	10.4	10.8
No change	0.0	0.0

Source: Author's field data, 2018

3.4.2.2 Effects of temperature changes on time of planting and weeding process

The western highland has two major planting seasons for food crop production; the first season which begins in March with the onset of the rainy season, and the second season which begins in August. It is important to note that the bulk of the food crops are grown during the first season in the western highland compared to the second season. This trend is commonly practiced in the North West than in the West regions. As gathered during focus group discussion, animals are allowed to stray and feed on farm residues after the first season harvest, thus discouraging second season cultivation of food crops in most parts of the North West region especially in the Donga Matung Division which is amongst the highest grazing areas in Cameroon.

Sixty eight percent of farmers have shifted planting dates (Table 12) – as the start of the wet season is getting progressively later each year (Kniveton *et al* 2008). As such the IPCC fourth assessment report which recommend adjustment of planting dates as an important option in agriculture.

Farmers supported these claims by explaining that *"In the 1970s we used to plant by the 15^th^ of March, but now rain does not fall at all during this period, or it comes earlier and disappears. Sometimes we the farmers are as confuse and we don't even know when to plant".* Farmers complained that *"The unsteady nature of rainfall caused them to suffer crop losses. They explained that when they plant at times during the first rain falls in February, the rain goes and only come back after a long time leading to poor germination, burnt, stunted growth and attacked by diseases.* A female farmer aged 42 concluded by saying that "*Because rainfall is fluctuating, I plant in February, March, April, depending on when rain falls".*

There is no significant statistical differences (P>0.005) between women and men farmers responses to shifting planting dates. Another farming activity affected by increase temperature is weeding.

Weeds are harmful because they reduce crop yield by competing for water, light, soil nutrients and space with crops. They also reduce crop quality by contaminating the crops, and serve as hosts to crop diseases, provide shelter for insects, interfere with harvest, and produce chemical substances which are toxic to plants, animals and humans. Therefore, the elimination of weeds from the farm, is a vital activity in food crop production.

Seventy-nine point seven percent reported that weeding becomes more difficult and time demanding as a result of increased in temperature (Table 12). Overall, farmers supported this claims by explaining that it is more difficult to pull the weed as the grass is dry and strong due to dry soil and less water. These observations are in accordance with those of Knox, Hess, and Ortola (2011), who reported that due to climate change, the soil in many African countries has become hardened and caked, rendering weeds sturdier and more robust.

Table 12: Effect of temperature changes on time of planting and weeding process

Effect of temperature changes			
Time of planting		**Weeding process**	
Effect	**(%)**	**Effect**	**(%)**
Has shifted	68.3	More work	79.7
Normal	1.6	More time	13.0
Fluctuates	10.2	Less work	7.3
Non-mastery of period	19.9	No change	0.0

Source: Author's field data, 2018. Between gender **(P>0.005)**

3.4.2.3 Effects of temperature changes on fertilizer and pesticide application

The survey observed that there is increasing awareness on the chemical effects of fertilizer and pesticide application across the western highland. Farmers were given four options to show the level of fertilizers applied on crops (increased, many more application, decreased and no change). Results from the ranking show that most farmers have increased their fertilizer and chemical application on their farms (Figure 9). Besides the effects of climate change, the western highland in particular suffers from infertile soils as a result of its high iron content which have pushed farmers into high use of fertilizer to improve soil fertility and subsequently crop productivity (Molua, 2008). Molua and Lambi (2006c), also found out that increase in temperature and decrease in rainfall reduces the soil water content and the amount of water retained in the soil. Dry soil were said to slow down the absorption of fertilizers by plants, but farmers who irrigated vegetable contrasted this view. A contrary, explanation was given by farmers who cultivate irrigated crops (carrot, cabbage, green spices and tomato) in Santa. As gathered during focus group discussions, these claims was attributed to regular watering of crops, which keeps the soil constantly moist, thus facilitating the absorption of fertilizers by plants.

The data presented in Figure 9 equally shows the effect of changes in temperature on the frequency and quantity of pesticides applied on food crops. Increased application of pesticides mentioned above complements the research of Schneider & Tol (2009), indicating that climate change increases pest populations such as weeds, pests and diseases. This is because warmer climate provides more favorable breeding conditions for pests which lead to increase use of pesticides.

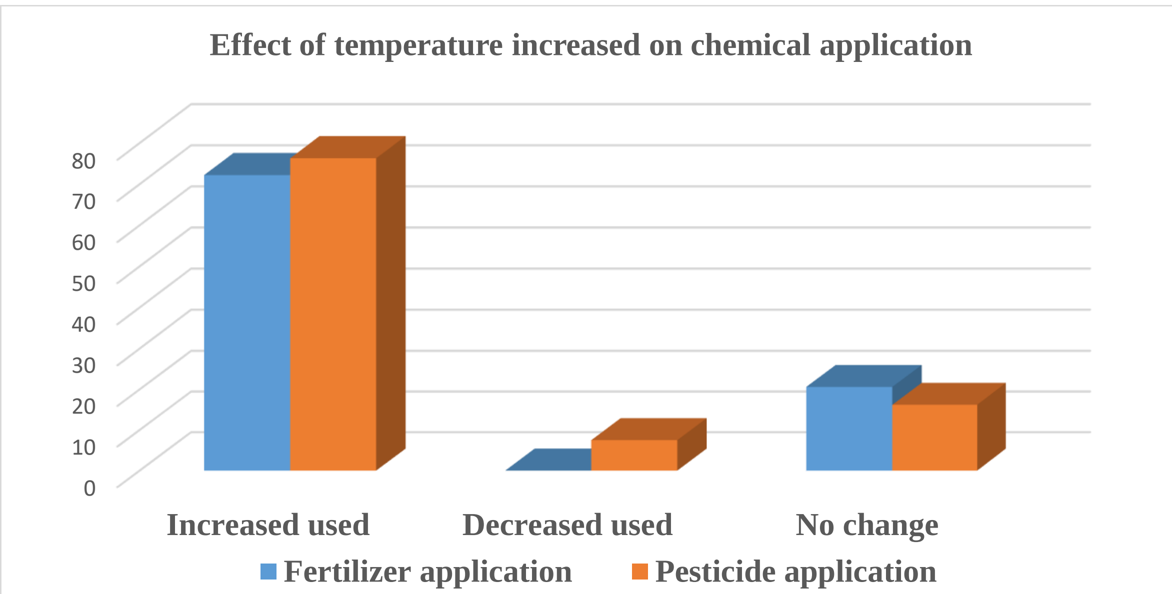

Figure 9: Distribution of farmers by effects of temperature changes on chemical application

Source: Author's field data, 2018

3.4.3.2 Effects of temperature changes on related farm activities by gender

Out of the 76.2% of farmers who perceived climate change as one of the obstacle in preparing land, has made it more difficult to prepare land, women (81.8%) had a higher percentage than men (70.6%) in Table 13. This is because women are primarily the ones who do clearing, tilling and planting related to land preparation in the rural areas following the urban migration of the youths and men.

This study shows changes in planting time, as many more women than men affirm this shift when planting any crops. More women (71.3%) than men (65.3%) change planting time for all the crops they grow. This gap is attributed to women's prolonged experience in food crop production which increases their ability to notice any change in the food crop production system.

More women (89.4%) than men (70.1%) stated that increased temperature hinders weeding, consistent with studies carried out by the SOFA team and Doss (2011) that weeding is predominantly female activity in developing countries including Cameroon. This finding also concord with works of Endeley and Sikod (2007), that women provide 60-80% of the labor required for farming activities including weeding in Cameroon.

Looking at temperature changes and fertilizer application on crop, majority of men (82.4%) than women (62.0%) stated that fertilizer application increases as temperature changes. This claim is attributed to higher involvement of men in irrigated and/or commercial crop (green spices, carrot, cabbage and tomato). In addition, men are usually the one who use inputs like fertilizer and pesticides so will easily know when its use increases over time. This difference in fertilizer used by gender was statistically significant ($P<0.002$).

Concerning pesticide application and gender, findings of this survey reveal that, more men (83.5%) than women (69.2%) reported having applied more pesticides as a consequence of increased temperatures. This difference could be explained by lack of means to acquire these chemicals by women.

Table 13: Effects of temperature changes on related farm activities by gender

	Women (%)	Men (%)
Effects on land preparation		
Too difficult	89.1	77.2
Easier	5.4	12.4
Fluctuate	5.5	10.4
No change	0.0	0.0
Effect on time of planting		
Has shifted	71.3	65.3
Fluctuates	25.7	33.5
Non–mastery of planting time	3.0	1.2
Effect on weeding process		
More work	89.4	70.1
Less work	10.6	29.9
No change	0.0	0.0
Effect on fertilizer application		
Increased used	62.0	82.4
Decreased used	9.1	5.3
No change	28.9	12.3
Effect on pesticide application		
Increased used	69.2	83.5
Decreased used	10.6	4.4
No change	20.2	12.1

Source: Author's field data, 2018. Between gender (P<0.002).

To substantial these claims above, farmers in Santa said, *"In order for Irish potato to bear well, we must apply ridomil mixed with wood ash to destroy the ants that eat up Irish potato leaves.* Another male farmers in Bafou explained that, *"I now apply more mocab (more than the quantities in the past) on plantain and banana suckers to reduce 'panama' which eats up the plantain especially now that places are hot.* Most in the two regions expressed the concern of maggot attack on maize. Majority said, *"We use to experience maggots in corn mostly during August planting season, but now even during the March season, excess heat brings a lot of maggot to corn making it not to bear well".* Farmers especially in the North West region raised the concern of disease on cocoyam leaves, but are unable to get any solution to remedy the situation.

3.4.3 Effects of rainfall changes on food crops

Although famers complained of overall decreased in rainfall, heavy rains during the month of June and July have negative effects on some crops as presented in the paragraphs below.

(i) The first effect of rainfall changes on food crops was increased incidence of pests and diseases as a result of heavy rainfall. These effect was noticed on crops like haricot beans, Irish potato, cocoyam, cabbage and tomato. As presented in Table 14, increased incidence of pest and diseases was reported by the following percentage of farmers and by crops: cabbage (77.2%) and tomato (76.1%), Irish potato (63.2%), cocoyam (59.5%) and haricot beans (31.9%). Pests and diseases resulting from variations in rainfall were not reported in the case of maize, groundnut, yam, banana, plantain, and sweet potato.

(ii) Another effect of rainfall changes on food crops was death of plant as a result of heavy rains. This was reported mostly on crops like, haricot beans (mostly climbers), Irish potatoes and sweet potatoes. For example, 46.6% of the farmers reported death of climbing haricot beans resulting from heavy rain towards maturity, followed by sweet potato (29.9%), and Irish potato (19.5%) as shown on Table 14.

Farmers also illustrates death of plants in the following ways. For the case of haricot beans, farmers recounted that, *"Too much rain during first season leads to blight attacks on leaves, poor flowering and pod formation hence leading to poor yields.* A lot of rainfall poses complications during post-harvest management of haricot beans in the North West region. This makes the grains to get rotten.

(iii) The third effect of rainfall changes on crops is wind damage. This was particularly noticed for banana and plantain towards the onset of the rainy season and dry season. Farmers reported that this is very common due to storms.

Although the findings of this survey show that both women and men grow food crop and are affected by climate change, women are generally more affected because of their high participation in food crop production, and they supply about 80% of the food consumed within the household and sell within the local markets (Endeley and Sikod, 2007).

Table 14: Effects of rainfall changes on food crops

Effects of rainfall changes on food crops	Crops											
	Maize	Beans	Groundnut	Yam	Irish Potato	Sweet potato	Cassava	Cocoyam	Banana	Plantain	Cabbage	Tomato
Decrease in yield	13.7	9.3	36.1	-	-	-	1.1	9.9	-	-	-	-
Increase in pests and diseases	-	31.9	-	-	63.2	-	-	59.5	-	-	77.2	76.1
Yellowing and drying of leaves	12.1	-	-	-	-	-	-	-	-	-	-	-
Tuber rot	-	-	-	21.0	7.0	-	-	-	-	-	-	-
Folding of leaves	-	-	10.9	-	-	-	-	-	-	-	-	-
Tiny leaves	-	-	-	-	-	-	-	-	-	-	-	-
Death of plant as a result of too much rain	7.1	21.8	-	46.6	19.5	29.9	-	-	-	-	-	-
Wind damage	-	-	-	-	-	-	-	-	78.4	80.2	-	-
Rotten of grains	-	-	13.1	-	-	-	-	-	-	-	-	-
Erosion of top soil	-	-	-	-	-	-	-	-	21.1	19.0	-	-
Drought resistant	-	-	-	-	-	-	-	-	-	-	-	-
Good growth	6.6	9.9	-	-	-	39.8	-	30.6	-	-	-	-
Disturbance of planting calendar	-	20.0	-	-	-	-	-	-	-	-	-	-
Slow germination	-	-	-	-	-	-	-	-	-	-	-	-
Increase in yield	-	-	-	-	-	-	-	-	-	-	-	-
No effect	51.1	7.1	40.0	32.4	10.3	39.1	71.0	-	-	-	28.8	23.9

Source: Author's field data, 2018

3.4.3 Effects of rainfall on related farming activities

3.4.3.1 Effects of rainfall changes on land preparation and planting process

It was generally observed that the length of rainy season has shortened though with heavy rainfall patterns in all the studied areas. Farmers' view on the effects of these changes are presented on Table 15. A greater proportion of farmers (39.6%) were in the opinion that land preparation has become more difficult with decrease in rainfall patterns, hence making it more demanding.

In terms of effect of rainfall changes on planting process, almost half of the farmers (40.0%) reported that planting becomes easier as a result of increase in rainfall. Farmers expressed that this was mostly noticed during the second season where planting is done immediately after chemical weeding.

Table 15: Effect of rainfall changes on land preparation and planting process

	Effect of rainfall changes	
	Land preparation	**Planting process**
Too difficult	39.6	27.5
More time	26.4	21.3
Easier	27.5	40.0
No change	6.5	12.1

Source: Author's field data, 2018

3.4.3.2 Effects of rainfall changes on time of planting and weeding process

The western highland has two major planting seasons for food crop production as already mentioned. Table 16 shows that 37.4% of the farmers noted a shift in planting time for most crops. About 25.5% noted that the time of planting is fluctuating and as such they do not have a fixed planting calendar while 18.8% expressed that because of these fluctuations they are confused regarding planting time.

Table 16 equally presents data on the effect of rainfall changes on weeding process. The analysis indicates that weeding becomes more difficult and time demanding as a result of increased in rainfall. Overall, farmers explained that mixed cropping make weeding to be more demanding. On the other hand, few farmers reported that weeding become less difficult with increased rainfall changes. This claim was mostly reported by the men who carryout chemical weeding immediately during these seasons. In Foumbot mono cropping of maize and haricot beans is common during the first and second season respectively. Meanwhile a minority are of the opinion that weeding process has remained the same over the past years.

Table 16: Effect of rainfall changes on time of planting and weeding process

Effect of rainfall changes			
Time of planting		Weeding process	
Effect	**(%)**	**Effect**	**(%)**
Has shifted	37.4	More work	40.0
Normal	18.0	More time	28.0
Fluctuates	25.8	Less work	22.4
Non-mastery of period	18.8	No change	9.6

Source: Author's field data, 2018

3.4.3.3 Effects of rainfall changes on fertilizer and pesticide application

Majority of the farmers' perceived decrease (37.2%) in the quantity of fertilizers applied on food crops and lesser rate of application (20.4%) with decrease in rainfall. This was mostly the case with farmers who cultivate varieties of food crops during the first season. During focus group discussions farmers attributed less use of fertilizers to regular rainfall which naturally cause the crops to grow well. Secondly, farmers hold that constant rainfall equally facilitates the absorption of fertilizers by plants. On the other hand, only 22.1% of the farmers perceived an increase in the quantity of fertilizers applied on crops. This was peculiar with exotic vegetables like carrot, cabbage, green spices, tomatoes and other crops like irish potato which consume a lot of fertilizer as explained by a male farmers in Santa. However, there was a significant statistical difference ((P=0.002)) between farmers who indicated an increase in fertilizers application and those who reported a decrease in fertilizers application due to decrease in rainfall patterns.

The data presented in Table 17 similarly shows the effect of rainfall variation on the frequency and quantity of application of pesticides on food crops. Overall, 45.6% of farmers indicated perceived increase in the quantity of pesticides application due to heavy in rainfall. Twenty seven point five percent of the farmers affirmed that because of these changes they have also increase the quantity of pesticide used. Conversely, 20.3% of farmers reported no change in the quantity of pesticides used. As confirm during a focus group discussion, this minority were those who cultivate only during the second season. A significant statistical difference (P=0.002) exists between farmers who stated an increase in pesticide application and those who indicated a decrease in pesticides application due to changes observed in rainfall patterns.

To substantial these claims above, farmers in Foumbot and Santa said, *"Recently we have noticed an increase in blight attack on Irish potato, tomato and haricot beans, hence causing us to increase and intensify the quantity of pesticide used".* Other farmers in Bafou suggested that *"Heavy rain washes off the chemicals, leading to increased and frequent used.*

Table 17: Effect of rainfall changes on fertilizer and pesticide application

	Effect of rainfall changes	
	Fertilizer application	**Pesticide application**
Increased used	22.1	27.5
Many more application	20.4	45.6
Decreased used	37.2	6.6
No change	20.3	20.3

Source: Author's field data, 2018. Increased and decreased used of fertilizer (P=0.002)

In summary, the effects of climate change (increase temperature or decrease rainfall) on farming activities are enormous. This pose difficulty in land preparation and weeding as well as increase frequency in the application of chemicals like fertilizer, pesticides etc. and hence increasing cost of production. All these are time and labor consuming activities as well as additional cost incurred for farmers especially for women as they are further time constrained by reproductive and community tasks. The high cost of chemicals put additional pressure on their traditional responsibilities of producing and providing food for the family. These pressure have a negative impact on women's health, food crop production, income and livelihoods.

3.4.4 Effects of temperature and rainfall variations on crop yields

The data presented in Table 18 shows the effect of temperature and rainfall changes on crop yield. Seventy six point four percent of farmers reported a decrease in crop yields across the western highland as a result of increase temperature. Farmers substantiated their claims saying: *"The leaves of most crops are twisted because of shortage of water, this reduces the growth rate resulting to low yields."* (A female farmer aged 51 in Ntumbaw village). Another female farmer aged 49 in Babessi explained that *"The yields of cocoyam has drop drastically now because the tubers are smaller in size and others even get rotten".*

The farmers further explained that in the past, seven stands of cocoyam could fill a bucket of 15kg, but now the quantity has dropped to less than half. A male farmer aged 58 in Bafou said *"Banana and plantain bunches are scanty and small in size".* Another male farmer aged 60 in Santa narrated that *"High temperature reduces water for the growth of crops. For example, the size of* Irish potato *has reduced, it makes maize plant to be stunted and the cobs are smaller in size, hence reduces crop yields.* This confirms findings reported by the International Potatoes Center (CIP) of decreased potato yields by farmers who did not adapt to climate change (Hijmans, 2003).

Although these findings reveal that both women and men farmers grow food crops and are affected by climate change, women are generally more affected because of their high participation in food crop production. Accordingly, women farmers are supposed to work harder and for longer hours to be able to produce and provide food for their family.

Similarly, studies by Knox *et al.* (2011) states that in Cameroon, temperature increase of 2 ^{o}C and 20% decrease in rainfall affected maize productivity by 11-14% decrease. Other findings from climate change effects (increase in temperature) in the Ogbomoso zone of Oyo state, Nigeria by Ayanwuyi *et al.* (2010), reveal low yields, stunted growth, increase incidence of pest and diseases, drying of seedlings after germination, and ineffectiveness of agricultural chemical due to delayed rainfall.

Unlike high temperature effects on crop yields, effects on rainfall variation indicated high yields for most of the crops except for climbing haricot beans. As mentioned earlier, farmers complained that heavy during first season affects flowering and pod formation climbing varieties of haricot beans. With the exception of haricot beans, the data presented in Table 18 on the effect of rainfall changes on crop yield indicate that 52.7% of farmers reported an increase in crop yields in the two regions.

Table 18: Effect of rainfall changes on crop yields

	Effects	
	Temperature changes on crop yields	**Rainfall changes on crop yields**
Increased	17.0	56.7
Decreased	76.4	40.1
No change	6.6	4.9

Source: Author's field data, 2018

It is worthy to note that farmers could not differentiate the perceived effects of climate change and those resulting from biological processes, such as, nutrient deficiencies (nitrogen, potassium, phosphorus deficiency etc.). However, more than half of the farmers reported that climate change had a significant impact on food crops. Consequently, these farmers reported a decrease in crop yields, as a result of increased incidence of pests and diseases, yellowing and withering of leaves and increase in tuber rots. These findings are in line with projections by the IPCC (2007) which indicated that climate change will affect agriculture through reduction in crop yields and increased incidence of pests and diseases. The International Potato Center (CIP) also reports that potential potato yield will decrease by 18%-32% in Cameroon in the absence to adaptation measures to climate change. In the same light, studies by Defang *et al*, (2014) carried out in Muyuka Sub Division of Cameroon, illustrate that decrease in yields is the most significant consequences of climate change.

Unlike decrease yields in most of the crop type, this was not the case with exotic vegetables (cabbage, tomato, carrot, green spices) as explained by majority of the male farmers in Santa. They narrated that high temperatures and intensive irrigation has favored the growth rate of these hence leading to increase in yields. These findings also affirm the work of Molua and Lambi (2006b), which explained that the prevailing conditions in the Western highland are conducive for the production of exotic vegetables.

3.5 Adaptation strategies to climate change

This section presents data on the different adaptation strategies employed by farmers to cope with the effects of excess temperature and changes in rainfall patterns. The Inter-Governmental Panel on Climate Change (IPCC) defined adaptation as adjustments or interventions which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate (IPCC 2001). Therefore, adaptation is meant to increase the capacity of a system to survive external shocks, such as increase temperature or decrease in rainfall pattern. Farmers expressed a number of adaptation measures as a response to the vulnerability of crops and farming activities to climate change. It was noted that both male and female farmers across the two regions in the western highland use similar adaptation strategies, though in different degree, owing to the gender differences in farming season and food crop cultivated.

Given that more than 95% of farmers across the agro-ecological zone perceived some changes in the climate, 84.0% of farmers confirmed that they use one or several measures to reduce the effects of either increase temperature or changes in rainfall patterns in order to attain sustainable food production. Findings further reveal that averagely more women (86.0%) than men (82.0%) adapted to these effects of climate change (Table 19). When asked why they adapt to these changes, farmers gave the following reasons, amongst others: A female farmer aged 45 in Babessi recounted that *"If I do not adapt to the changes, I will not have any food (maize, haricot beans) to feed my family, sell and earn some money to pay children school fees".* A male farmer aged 65 in Ntumbaw explained that "*construction of storage barn especially for beans is very crucial, if not harvested beans will all get rotten.*

However, it was observed that 26.0% of farmers failed to take up any adaptation strategies to reduce the effects of climate change on crop production activities (Table 19). This group of farmers said *"They do not have any knowledge on adaptation strategies and so they rely on God Almighty and ancestors for better harvest".* A male farmer aged 53 in Ntumbaw narrated that *"I do not know how to cope with this new climate, and beside the agricultural extension agents avoid discussions related to this topic".*

Table 19: Distribution of farmers who adapted to climate change

Adapt to climate change	**West Region**		**North West Region**	
	Women (%)	**Men (%)**	**Women (%)**	**Men (%)**
Yes	80.0	70.0	92.0	94.0
No	4.7	10.3	7.1	3.9
Neutral response	15.3	19.7	0.9	2.1

Source: Author's field data, 2018

3.5.1 Adaptation strategies employed by farmers

Farmers have employed a variety of adaptation strategies to mitigate the effects of climate change on food crop production activities; methods like irrigation, application of pesticides, application of fertilizers, shifting of planting dates and construction of storage barns were used. Shifting of planting dates was the most common practice for farmers across the zone, followed by construction of storage barns, application of fertilizers and pesticides. These strategies were commonly practiced by both women and men as observed in the two regions.

The main adaptation practices employed by farmers to cope with the effects of excess temperatures were as follows: shifting of planting dates, application of pesticides and application of fertilizers while that for changes in rainfall patterns were same strategies used in addition to the construction of storage barns. In conformity with this, findings of Tijani and Baruwa (2011) in Osun State in Nigeria say used of chemical inputs are current measures used in improving crop production. Studies of Molua and Lambi (2007) in Cameroon also reported similar results that farmers confronted with increased temperature and changes in rainfall conditions adapted to spreading out planting dates (early or late planting).

Unlike shift in planting dates where farmers delayed planting during the first season cultivation, this was the reverse for some crop types. Farmers narrated that for some crop types like climbing haricot beans, it is planted immediately after the first rains towards the end of February such that they are matured before the heavy rains in July. Still in line with this crop, farmers said they had better yields with climbing haricot beans cultivated in valleys compared to those planted on slopes during the second season. Farmers in Ntumbaw explained that these crops attained maturity without being affected by drought since it takes a longer time (90-110days) to mature.

The use of pesticides was also common amongst farmers who grew crops like tomatoes, haricot beans and Irish potato. A male farmer aged 47 in Babessi said *"I apply more pesticides on beans in order to have good yields especially during the rainy season cultivation".*

Accordingly, FAO (2014) reports that farmers using the adaptations measures mentioned above showed improvements in crop yields, food security and subsequently improved livelihoods.

Table 20: Distribution of adaptation strategies used by farmers

Adaptation strategies employed	**Climatic effects**	
	Temperature	**Rainfall**
Irrigation (watering)	35.6	0.0
Application of pesticides	70.0	70.3
Application of fertilizers	52.2	30.7
Shifting of planting dates	100.0	100.0
Mulching	29.2	40.7
Construction of storage barns	25.5	68.2

Source: Author's field data, 2018

3.5.2 Gender and application of adaptation strategies

Although both men and women adapt to climate change, majority of men practice irrigation methods and use chemicals like pesticides, and fertilizers. It was observed that this was mostly done by farmers who grew temperate crops such as carrot, green spices, tomato, cabbage and leafy vegetables during second cycle. Therefore, irrigation has a bearing on crop grown and farming season practiced. Farmers expressed that these crops are generally grown by men for commercial purpose, hence men increased use compared to women. On the other hand, majority of the women grow traditional crops (cocoyam, maize, haricot beans, Irish potato, cassava), principally for family consumption.

It was further observed that because of climate change, farmers, especially women, now make use of chemicals inputs such as fertilizers, pesticides and herbicides which was not the case before but still use less compared to men. Increased incidence of pests and diseases, alongside difficult land preparation, weeding and low yields couple with the mostly infertile soils with high iron content (IRAD, 2008) are factors which influence women farmers' use of chemicals. However, the high cost of these chemicals puts additional pressure on their traditional provisioning responsibilities.

As reported by Lambrous and Piana (2006), women are less likely to respond to climate change that men because of household division of labour which gives women the traditional responsibility of taking care of the sick, fetching water, cooking food, and growing food crops in home gardens and far away farms. These changes has resulted in shifting planting date irrespective of gender in both regions. It was observed that women more than men used storage barns especially in the North West region. This is because they are in the majority of those who cultivate cereal and grain crops like haricot beans, soybeans, cowpea and groundnuts.

Table 21: Gender distribution of adaptation strategies by farmers

Adaptation strategies used	West Region		North West Region	
	Women (%)	**Men (%)**	**Women (%)**	**Men (%)**
Irrigation (watering)	34.2	66.8	43.7	57.3
Application of pesticides	45.1	54.9	34.6	65.4
Application of fertilizer	48.3	52.7	39.6	60.4
Shifting of planting date	100	100	100	100
Mulching	80	20	80	20
Construction of storage barns	00	00	80	55

Source: Author's field data, 2018

Farmers used the following statements to explain the strategies. Regarding shift in planting dates as adaptation option, a female farmer aged 44 in Bafou expressed that *"nowadays, I exercise patience and wait until rains are stable before I can plant, because in the previous years I planted haricot beans in February after the first rainfall and it stay for almost three weeks before rain was stable. This caused me to lose all the haricot beans because it got rotten and I had no other seeds"*.

A male farmer aged 55 in Foumbot said *"recently I have move my planting period to first week of April and I have been succeeding since then because the soil is not too dry like in March"*.

Application of pesticides was another measure most farmers reported having used. Ridomil or Gamalin were the common chemical substance used. They explained that it is mixed with wood ash to get rid of pests like stem borer in maize, ants around cocoyam and the white flies around vegetables and cassava. A female farmers aged 42 in Babessi said *"If I do not apply "medicine" (pesticides) on my farm during second season which is the main planting season for beans, I will not be able to have good yields because of too many insect attacks"*.

Concerning the use of fertilizers, farmers said this is very important especially when the soil is very dry especially between the months of December to February. A male farmers aged 40 in Ntumbaw said *"I mostly apply fertilizer (sulphates) especially on plantain and banana to provide water to the plants at the heart of the dry season"*.

In terms of irrigation, a male farmer aged 42 in Santa explained that *"My crop will die if I do not water them, because the soil is very dry especially between December and January month when the demand for these crops are high".* Another male farmer aged 40 in Foumbot said *"I water my crops constantly during the second season because this is when I produce vegetable the most. To achieve this, I use pumping machine to supply water into the farm because the soil is too dry."* Meanwhile a female farmer is Santa narrated that *"My entire household and I water the crops (cabbage, green spices and huckleberry) every evening with the use of self-made water spray because of too much sunshine".* As recounted by another female aged 43 in Santa, "*We are force to water crops especially vegetables, if not we would not be able to sell and have money to take care of Christmas needs for the family".*

It was observed that farmers used similar strategies to cope with the different effects of climate change. The commonly used strategies to mitigate the effects of excess rainfall towards harvest period especially for haricot beans is the used of storage barns (Figure 10). This is a common practice in Donga Mantung Division where almost every household as seen in Ntumbaw had this either in the farms or around the house. Farmers from Ntumbaw harvest pods and stored them in storage barns, and only thresh pods to get the grains as the need arises. This group of farmers reported that storing in the form of grains affects the quality, color, viability of seeds as well as its market value.

Figure 10: Pictures showing adaptation strategies for post-harvest activities of beans

Source: Author's field data, 2018

3.6 Factors limiting adaptation to climate change

This section presents the findings on the factors limiting farmers to adapt to climatic variations on food crops production. Analyses of the factors which prevented farmers from adapting to climate change in the western highland revealed five constraints as presented on Table 22. The information on the table indicate that only women reported the concern of insecure land rights as barriers to climate change adaptation. The existing gender gap in the use of irrigation by women, is attributed to land tenure practices, whereby majority of the women report that they do not own the land on which they farm (focus group discussion). Lack of proper land tenure rights by women constitute a disincentive for implementing durable adaptation measures like irrigation. This was mostly reported in Foumbot where farm land is scare and as such majority of women farmer cultivate on rented land. They explained that land owners usually do not allow tenants to grow annual crops or even trees which could also serve as an adaptation measure against wind damage.

Although both women and men reported limitation factors such as lack of money, lack of knowledge on adaptation measures and lack of farming equipment, more women expressed these concerns than the men. Conversely, majority of farmers made use of those adaptation measures which do not require land tenure rights, but which are climate-dependent such as shifting planting dates. The fact that 100% of farmers tend to shift planting date can be credited to their long experience in food crop production. Though majority of the men are new into food crop production business, they had started gaining experience that women had gathered over the year. However, these measures do not guarantee that harsh climatic conditions will be completely avoided, especially if rainfall ceases for a long period before the next rain.

In sum, across the two regions, majority of farmers (73.9%) identified four major factors as hindrance to adapting to climate change, they are (i)-Lack of money (ii)-Lack of right over land (iii)-Lack of knowledge on adaptation measures (iv)-Lack of farming equipment (Table 22).

Table 22: Distribution of farmers by factors limiting adaptation

Factors limiting adaptation	Farmers (%)	
	Women	**Men**
Lack of money	59.0	38.5
Lack of right over land	71.2	46.1
Lack of knowledge on adaptation	68.0	0.0
Lack of farming equipment	73.0	13.0
Uncontrolled phenomenon	3.7	7.3

Source: Author's field data, 2018

Majority of the farmers who reported lack of money as adaptation limitation explained that they needed money to construct storage barns for maize and other grains like haricot beans, soya beans and cowpea while other said they lack the necessary means to purchase chemicals (herbicides, fertilizers pesticides). For example, a female farmer aged 67 in Babessi said *"I just manage the farm the way it is because I do not have money to buy "medicine" (pesticides) and even fertilizer to increase crop yields like I see in my husband farm".* A male farmer aged 49 in Santa also narrated that *"I lack money to buy irrigation equipment for my farm, so we use family labor to water the farm during the dry season".*

With regards to insecure land rights, a female farmer aged 49 in Foumbot recounted that *"My landlords told me to plant only beans and corn because I can leave at any time he desires to farm on the land, so there no need to plant tree as an adaptation measure".*

In terms of lack of knowledge about adaptation, a female farmer aged 70 in Ntumbaw said, "*I do not know what can help me to increase my food crop production.* When asked if she has ever used pesticide or fertilizer, "*She said I do not know what they do to crops".*

Most farmers who raised the concern about lack of farm equipment, complained more specifically about the absence of irrigation facilities.

It is observed that women are more vulnerable to poverty and have less access to education than men. This can have a negative impact when adapting to climate change as wealth and education are important determinates on adaptation strategies where wealth and education have a positive implication to adoption of climate change adaptation strategies (Gbetibouo, 2009).

Conclusions

The profile of the farmers studied was dominated by aged married women and men with primary educational background and who depended solely on farming and trading activities for livelihood. Results on the different crops types grown by farmers in the western highland show that majority of farmers cultivate maize, haricot beans and different food crop during both season.

Results on perception of climate change indicate that farmers are aware that temperatures are increasing while rainfall is decreasing which affects both farming activities and crop yields. Gender wise, these observation was higher for women than men.

Farmers equally perceived that these changes cause increased incidence of pest and diseases, yellowing of leaves, tuber rots hence affecting crop yields. In terms of effects on related farming activities, farmers perceived difficulties in preparing land for cultivation, weeding, reduction in quantities of fertilizers applied, increase in pesticide application leading to shift in planting dates.

As a result of the above mentioned effects, farmers reacted by adopting some strategies to reduce the effects of climate change on food crop production so as to sustain food production. Farmers used strategies such as increased quantity and application of pesticides and fertilizers, irrigation and shifting of planting dates. In terms of gender, irrigation was used by more men than women in the two regions. Many more women than men used climate-related adaption measures such as shifting of planting dates.

However, some farmers perceived climate change but failed to adapt due to lack of credit and lack of farm equipment as well as knowledge about adaptation measures. Only women farmers reported lack of farm equipment as constraints to adaptation.

Therefore, supporting farmers in increasing adaptation measures through empowering them on effects and adaptation measures to climate change can significantly help farmers increase and sustain high productivity levels even under changing climate conditions.

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